



Landmark Environmental, LLC

2042 West 98th Street

Bloomington, MN 55431

Phone: 952-666-2444

February 5, 2016

Sent via email

www.landmarkenv.com

Mr. Allan Timm and Ed Olson
MPCA VIC Program
520 Lafayette Road
St. Paul, MN 55155-4194

Re: **In-Situ Chemical Oxidation Groundwater Remediation Work Plan
Minnesota Bio Business Center Project
221 First Avenue S.W., Rochester, Minnesota**

Dear Mr. Timm and Mr. Olson:

On behalf of the City of Rochester (the City), Landmark Environmental, LLC (Landmark) has prepared this in-situ chemical oxidation groundwater remediation work plan (Work Plan) for the above-referenced property (the Property) shown in **Figure 1**. The scope of work presented in this work plan will be implemented by Landmark and ORIN Technologies, LLC (ORIN).

SCOPE OF SERVICES

Prior to chemical injection activities, the dual-phase extraction (DPE) system will be turned off and the active venting systems will be turned on. A sodium permanganate solution will be injected into each of the eight DPE wells by ORIN. **Figure 2** shows the location of ORIN's treatment trailer and water truck, the location of the fire hydrant for water access, and the basement layout out of the DPE system. The hoses used for transferring the solution used for chemical injection will be routed from ORIN's treatment trailer, along the west alley, and through the DPE system exhaust piping to the basement of the MN Bio Business Center Building. Therefore, the DPE exhaust piping will be disconnected from the DPE pump in the DPE room to allow the injection hose through.

After the chemical injection event is completed, the DPE system will remain off indefinitely and the groundwater will be monitored on a quarterly basis to assess the effectiveness of the chemical injection. After one year of post chemical injection groundwater monitoring, Landmark will provide recommendations concerning future groundwater remediation options, if necessary, for MPCA approval.

The primary contaminant of concern (COC) is tetrachloroethene (PCE), with the highest PCE concentration found at DPE-3 shown in **Figure 2**. The site specific clean-up goal for the ISCO groundwater remediation technology is 50 ug/L PCE, which is ten times the Minnesota Department of Health (MDH) Health Risk Limit (HRL) of 5 ug/L for PCE.

Chemical Injection Summary

- Treatment chemistry injection will utilize 8 drilled DPE wells previously installed.
- The vertical extent of remediation shall vary but averages 6 to 18-ft bgs.
- Implementation in the field will take approximately 5 days depending on unforeseen site and matrix conditions.
- Inject an average of 850 gallons of 5% sodium permanganate treatment chemistry into each of the 8 DPE wells (6,800 total gallons).
- Concentration and volume may vary depending on unforeseen site conditions and contaminant load at each area.
- ORIN will maintain field notes on the location of the injection points, amount of chemical injected, and any other injection related field observations.
- A brief report describing the remediation, chemical amount used, other field information, and observations regarding the remedial effort will be submitted to MPCA after all field work is completed.

INJECTION METHODOLOGY

ORIN will inject the preferred treatment chemistry through the DPE wells. The injection equipment will be pressure tested with water prior to the beginning of injection activities. The treatment chemistry will be injected into a well slowly to ensure proper flow rates and safe injection pressures. Once safety measures are checked and confirmed, ORIN will inject the treatment chemistry to effectively disperse the treatment chemistry into the subsurface. The pressure, rate, and total volume of treatment chemistry injected would be monitored by ORIN and amended according to field conditions in order to ensure maximum injection effectiveness.

Chemical Mixing and Delivery Methodology

The remedial injection treatment chemistry will be prepared using ORIN's specialized injection equipment which will be set up in the basement of the Minnesota Bio Business Center building in the room adjacent to the DPE room. The treatment chemistry will be mixed and temporarily staged prior to injection in 200 gallon tanks. The tank will first be filled with the proper amount of water to achieve the appropriate treatment chemistry solution concentration. The desired

amount of permanganate will then be added to the water in each mixing tank. Multiple tanks will be mixed and used during the injection, which enables work to proceed steadily and efficiently.

The treatment chemistry will be pumped into the formation using ORIN's air-driven, chemically resistant pumps. The rate, pressure, and volume will be monitored using a chemically resistant inline electronic flow meter. Shut-off valves are present at numerous locations throughout the delivery system for health and safety purposes.

Flow meters, injection pressure gauges, and pressure relief valves are located on ORIN's specially designed "injection heads" which connect the treatment chemistry feed line to the injection location. Each of the injection heads are constructed out of 1-inch schedule 80 PVC pipe fittings for added pressure resistance and durability. The injection head allows for ORIN personnel to monitor real time injection pressures with Ametek 0-100 psi pressure gauges. Flow rates will be measured with GPI industrial grade flow meters (model G2P10N09GMA).

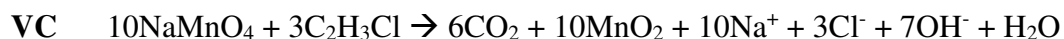
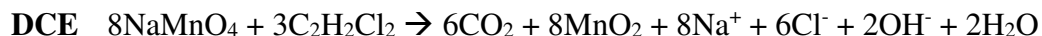
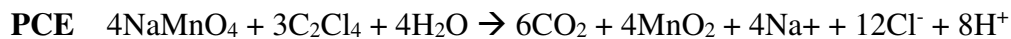
Decontamination and Waste Management

Prior to mobilization, all of ORIN's equipment including pumps, tanks, hoses, injection heads, and rig will be properly decontaminated using specialized chemical treatments and procedures. All waste will be properly disposed of according to standard regulatory protocol. Landmark will properly dispose of all empty chemical containers.

PREFERRED TREATMENT CHEMISTRY DESCRIPTIONS

Sodium permanganate (NaMnO_4) is a strong oxidizing agent that was originally discovered in the 18th century. As an oxidizing agent sodium permanganate has the ability to add oxygen, remove hydrogen or remove electrons from an element or compound. The molecular weight of sodium permanganate is 142 g/mol. Permanganate is recognized by its characteristic purple to pink color when made into a solution.

Sodium permanganate has been successful in the reduction of chlorinated solvents in a wide array of field implementations. A benefit of a permanganate remediation approach is the complete oxidation of the contaminant without the formation of intermediate compounds commonly found with biodegradation. For example, the breakdown of common organic solvents with sodium permanganate (NaMnO_4) is as follows:



Sodium permanganate is an inorganic oxidant that performs chemically the same way as potassium permanganate, only in a more concentrated form. The significant advantage to sodium permanganate is its high solubility in water, allowing it to be a more convenient and concentrated form of permanganate when used for organic oxidation of contaminants.

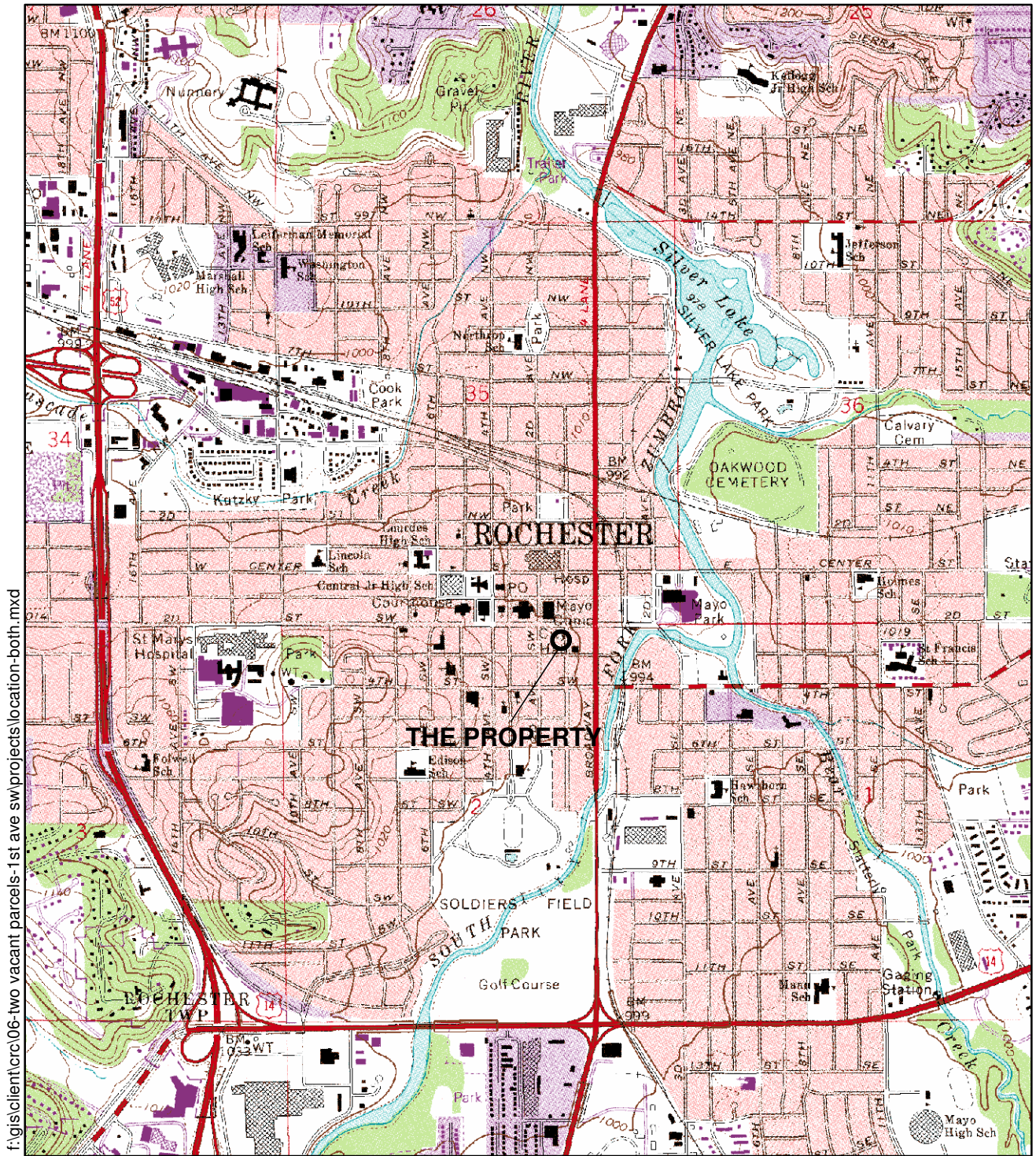
Please contact me with any questions or comments concerning this Work Plan at jskramstad@landmarkenv.com or 952-666-2417.

Sincerely,



Jason Skramstad
Vice President/Environmental Engineer
Landmark Environmental, LLC

CC: Terry Spaeth, City of Rochester



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Source: Rochester, Minnesota Topographic Quadrangle, 7.5-Minute Series

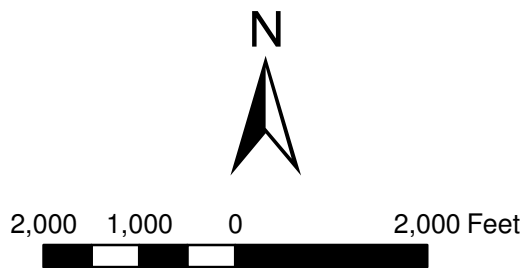
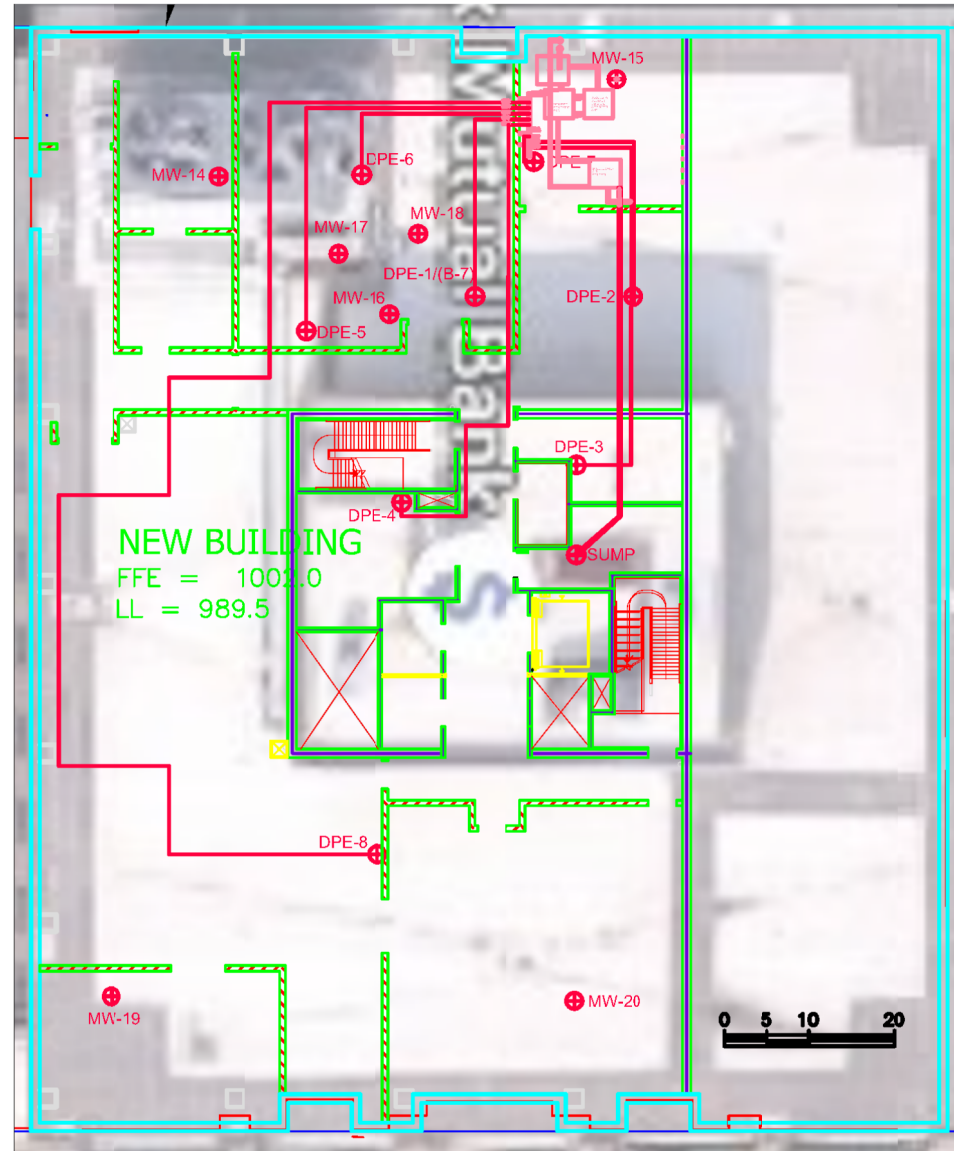
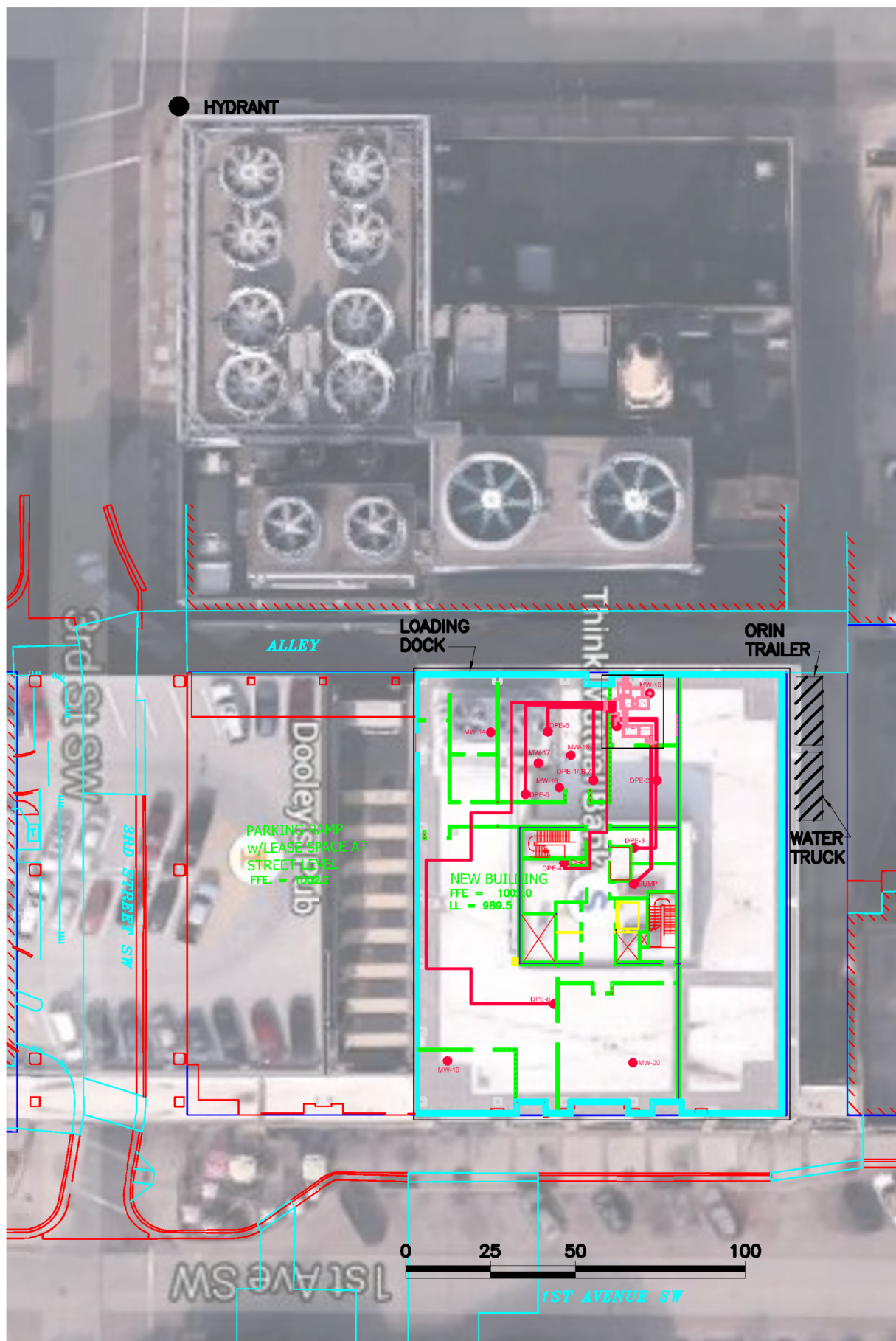
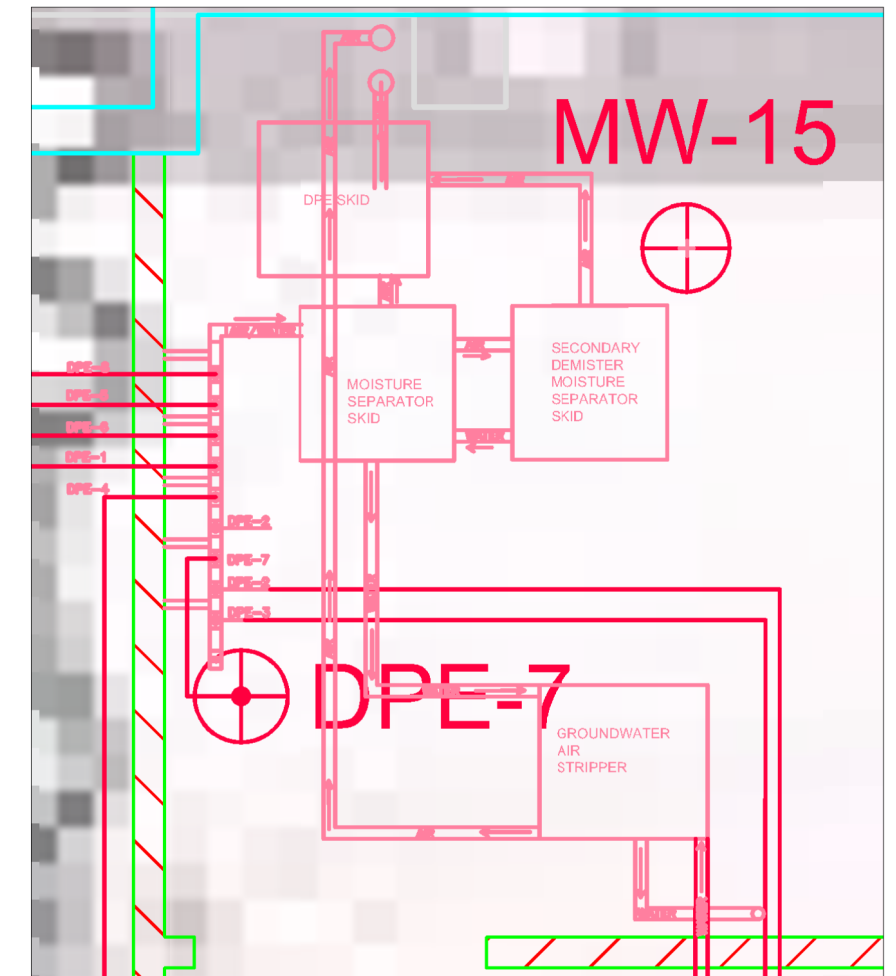


FIGURE 1

PROPERTY LOCATION MAP
221 1st Avenue Southwest
Rochester, Minnesota



BASEMENT FLOOR PLAN



DPE SYSTEM ROOM

Rev	Date	By	Description

LANDMARK ENVIRONMENTAL, LLC
2042 West 98th Street
Bloomington, MN 55431

FIGURE 2
SITE LAYOUT MAP
221 FIRST AVENUE S.W.
ROCHESTER, MINNESOTA

Landmark Project Number: CRC			
Drawn: JDS	Checked: JDS	Designed: JDS	
Scale: SHOWN	Date: 1/26/2016	Revision:	
Drawing Number:	Sheet	Of	Sheets